TEACHERS' HAND BOOK FOR YAGGY'S ANATOMICAL STUDY

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TEACHERS' HAND BOOK:

DESIGNED TO ACCOMPANY

Yaggy's Anatomical Study.

PREPARED BY

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SUGGESTIONS TO THE TEACHER.

The exercises provided in the following pages are intended to be merely suggestive. They may be considerably varied and extended. In the first lessons of the course proposed, the minute details of questions and probable answers have been given, to indicate what is believed to be the best method of presenting the subject to the younger minds. It is recommended that you continue this plan of work through all the lessons.

It is important that you should, beforehand, fix clearly in mind, in orderly succession, the facts you wish to teach in each lesson. Make yourself so familiar with the plates on the "Study," that your references to them will be prompt and accurate. Provide yourself with a neat pointer, instead of a clumsy stick which would largely obscure the figure. Do not hurry over the work, but do it thoroughly. If you find a prescribed exercise too long for a lesson, make two or more lessons of it.

Do not by any means, neglect to pursue this work with regularity and perseverance. The patrons of your school having provided you with "Yaggy's Anatomical Study," and thus giving you rare facilities for instructing their children in Physiology, will look for the results. The realization of their expectations will depend on your determination and effort to make the best of your opportunities. Do not be content with giving your pupils a few lessons from the plates of the study, and then laying it aside to be forgotten. Make it a part of your programme at regular times. It will be very easy to create such an interest in this science among your pupils that your work will be known and appreciated in their homes, and thus result in your favor.

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PREFACE.

This Hand-book is intended to be helpful to teachers who, from a want of experience in teaching or from a lack of information on the subject of Physiology, need some suggestions—either as to method or matter—in presenting the study to their pupils. It will also be found useful to more experienced instructors, not as offering them anything in lieu of their own resources, but in giving them additional hints and ideas, and thus adding variety and efficiency to their work.

The rapidly growing interest in the study of Physiology—manifested not only among the more enterprising teachers and school officers, but also in educational legislation—has increased the demand for the best helps and appliances for an intelligent and successful introduction of this important branch of knowledge in our public schools. To aid in this good work is the object of the beautiful and complete "Anatomical Study," with which this little manual goes into the school-rooms of the country. At the same time the increasing popular and legal demand for instruction in Physiology has taken many younger teachers by surprise. To furnish such with help is the mission of these pages.

Furthermore, there is a growing demand for instruction in our schools on the destructive effects of Intemperance, as they appear from the physiological outlook. This requirement comes quite unawares, not only to the younger, but to many older teachers. To all such, this Hand-Book will be both welcome and invaluable, inasmuch as the course of exercises which it furnishes on this subject, used in connection with the graphic representations of the temperance plates of the "Study," is believed to be the most intelligent exposition of the ruin of the body by alcohol that has yet been proposed for use by the instructors of younger pupils.

DIRECTIONS FOR OPENING THE STUDY.

WHICH PLEASE READ VERY CAREFULLY.

IN CLOSING THE STUDY SEE THAT NONE OF THE PARTS ARE DOUBLED.

LAY the study before you on the table, with the fold to the right. Grasp the fold with both hands on either side, at the joint, and give it a slight jerk. This will remove the clasp. Raise the chart slightly with the left hand, and with the right double the fold on the underside. With the left hand grasp the upper right part of the Study with the fingers on top and the thumb underneath, and raise it about four inches. With the right hand raise the section of skin and include it in the grasp of the left hand. Be sure and do this, otherwise you will get the parts of the body out of their proper places. You are now ready to open the manikin. With the left hand turn back the upper lid, together with the body manikin; at the same time elevate the other side with the right hand, until you have the two sides in an upright position, not quite vertical.

Retain your grasp with the left hand, and insert the clasp of the lid below with the right hand. This position of the Study will bring before you the title page. Turn this clear over, which will expose to view the skeleton; after laying this back we come to the muscles, arteries, veins, etc. Then we have the view which shows the nervous system. This is followed respectively by the map of blood formation, its purification and circulation, and three plates illustrating the effects of alcohol and narcotics upon the vital organs of the body. Turning over the last of these you will see the manikin of the head, the eye and the ear. After removing skin of the head manikin, lift off the skull, then the muscles of the lower jaw, after which take off the section containing the teeth and the eye ball then the brain, which splits the head right in two. The eye and the ear require no explanation, for the mechanism is very simple and plain.

After having viewed these three manikins, turn back again to the original positions all of the plates. Now, turn the whole study half way around, bringing to the front the body manikin. Remove first the skin, then the muscles; after having laid to one side the ribs and examined the different parts of the lungs, throw this whole section back over the top of the Study, out of the way, which will leave before your view the liver. After turning the latter upside down, lay it to one side, and you will have the full digestive apparatus. Now, split the stomach in two and remove the intestines, and you will have the whole background of the chest and abdomen. Be careful in putting these back to get them in their proper places: first, the intestines; second, the upper half of the stomach; third, the liver; fourth, bring down from the top the whole of the lungs, after which turn over the ribs, then replace the right hand piece or the muscles; lastly, the left hand piece of the skin.

Now, in closing, turn the Study with the title page to the right hand side. Grasp the left hand side in the middle, on the outer and lower edge, and elevate it a little. With the right hand give a slight rap on the lower part of the case, which will remove the clasp. Then bring the section clear over, holding within the grasp of the left hand the skin surface of the body manikin. Then draw the flap from beneath and bring it over to the top and insert the clasp. Be careful and do not have the parts disarranged when the Study is closed.

TEACHERS' HAND-BOOK FOR
YAGGY'S ANATOMICAL STUDY.

EXERCISE I.

SKELETON PLATE.

What have we here, pupils? Johnnie perhaps answers: "A man." Mary may say: "They are bones." After drawing out numerous answers from the class, state as follows:

This is the framework of the body, and it is called a "skeleton." All pronounce the word. Pupils—Skeleton. It contains about 208 separate pieces called bones.

I want you to observe the different shapes of these bones. James, what particular one are you noticing now? James—The long one which forms the leg. Teacher—Yes, that is a long, straight bone. Mary, what differently shaped one do you see? Mary—I am looking at the flat one at the shoulder. Teacher—Yes we have flat bones also. What other shaped bones do you see, children? Some call attention to the skull, some to the ribs, and so forth. In this way discuss and bring out the different shapes of the bones.

Now, we are going to learn more about these bones. Since there is so large a number of them, we can study them best in divisions or groups. How many different groups do you see, scholars? Perhaps half a dozen hands will go up. One says he sees two groups; another three; some possibly four. After getting numerous answers, state:

There are three distinct groups—the bones of the head, of the trunk, and the limbs or extremities. This last division may be divided into the upper and lower extremities or limbs.

This, no doubt, will be sufficient material for your first lesson.

How many of you will be willing to bring a specimen of bone to the class to-morrow, when we have our next drill? A number of hands will rise. Delegate Charles to bring a long, slender bone; Frank a flat bone, and so on; so that you will have the differently shaped bones for to-morrow's lesson.

Now, let us review what we have learned. In the first place, what do you call this? P.—Skeleton. T.—Of what is it composed? P.—Bones. T.—How many are there? P.—208. T.—What shapes? P.—Long, straight bones; flat bones; curved bones and round bones. T.—How many different groups of bones are there? P.—Three. T.—Name the first one. P.—Head. T.—Second? P.—Trunk. T.—Third one? P.—Limbs. T.—How many divisions of the extremities or limbs? P.—Two. T.—What are they? P.—Upper limbs and lower limbs.

Now, in to-morrow's lesson we will learn more about these bones in the head.

EXERCISE II.

SKELETON PLATE.

T.—How many groups of bones did we find in the skeleton in our first lesson? P.—Three. T.—(Pointing to skeleton) Harry, what is this group called? Harry—The head. T.—Laura, name this part of the body. Laura—The trunk. T.—Maggie, what are these parts called? Maggie—The limbs. T.—Have you brought any specimens of bones? (Examine and compare such specimens.)

Now, let us learn more about the head. Draw out by questions ideas about its shape. Then pointing to the forehead on the plate, ask: What do you call this part of the head? Some will answer: The forehead. Others may say: The front part. Approve both answers. T.—Place your finger on the front part of your head. Do you feel a bone there? P.—Yes. T.—This large bone in the front part of the head is called the frontal bone. (Teacher spells the name and writes it on board.)

NOTE.—Figures in this guide mean that the teacher shall point to the corresponding part of the plate.

Teacher—What is this (3) part of the head called? Most pupils will answer: The side. Some may answer correctly: The temple. If not, state that it is called the temple. T.—Place your finger on your head at this (3) place. Do you feel this bone there? P.—Yes. T.—This is not the same bone you felt before. Since it is in this part of the head it is called the temporal bone. T-e-m-p-o-r-a-l. How many can write that name? (Hands rise.) T.—Charlie, you may write it on the board. Remember there are two temporal bones, one on each side of the head.

Touch the back of your head. Now, you feel the bone which is shown here (4). Its rather hard name means the back of the head. I will write it on the board: O-c-c-i-p-i-t-a-l, occipital. What is this bone called? P.—Occipital bone. T.—Now, we have learned a few of the names of the head bones. By-and-by you will learn the names of all the bones in the body. It would be too hard for you to learn and remember all their names now. But you must be sure and remember all that you do learn.

NOTE.—As these are simply general questions to assist the teacher in conducting this exercise, he must use his judgment as to whether or not it is best to teach the pupils the names of the bones at this early stage of the study. Teachers who prefer to do so will find all the aid they need in the index to the skeleton on the plate.

Teacher—There are twenty-two bones in the head. What parts of the head do you notice, scholars? P.—The face, upper part, back part. T.—The upper and back part is called the skull or cranium. There are eight bones in the skull. Notice that this plate shows us how and where these skull bones come together. (Teacher calls attention to the division lines and sutures.) They seem to be put together so as to make a sort of round box. That is exactly the case. These eight skull bones of the head are put together in box form, to contain and protect one of the most delicate and important parts of the body. How many of you know what is contained in this bone-box? (Hands up.) T.—All who know may tell me. P.—The brain. T.—Correct. We shall learn more about the brain hereafter. So the eight bones of the skull may be called the brain-box.

We will have another lesson on the bones of the head to-morrow.

EXERCISE III.

SKELETON PLATE.

Teacher—How many bones did we learn are in the head? Pupil—Twenty-two. How many of these are in the skull? P.—Eight. T.—Now, Susan, tell me how many must be in the face? Susan—Fourteen. T.—Correct; there are fourteen bones in the face. What different parts of the face do you notice? P.—Nose, eyes, mouth, cheek. T.—What is this (5). P.—The nose. T.—Is it the whole of the nose? P.—No. T.—What would you call it? P.—Skeleton of the nose. T.—Here (5) are two small bones which make the bridge of the nose. What is this (6) part of the face called? P.—The cheek. T.—So here (6) are two cheek bones. Harry, what would you call this (7) bone? Harry—Jaw-bone. T.—Mary, what would you call this (9) large bone? Mary—Jaw bone. T.—How then can we tell between this (9) jaw-bone and this (7)? P.—By calling them upper and lower jaw-bones. T.—Correct. Now, what else do you notice about these jaw-bones? P.—The teeth. T.—Right. The teeth are firmly set in these bones. Now, what seems to be the use of these face bones, of which we have spoken? (Draw out: to shape the nose, the cheek, the chin, and to contain the mouth, teeth and so forth.)

Now, let us see what we have learned about the bones of the head. What is this (1) bone called? P.—Frontal bone. T.—This bone? P.—Temporal bone. T.—This on the back of the head? P.—Occipital bone. T.—How many bones in the head? P.—Twenty-two. T.—How many of these in the skull? P.—Eight? T.—What is the use of this skull-box? P.—To contain and protect the brain. T.—How many bones in the face? P.—Fourteen. T.—What are these (5)? P.—Bones of the nose. T.—These (6)? P.—Cheek bones. T.—This (7)? P.—Upper jaw-bones. T.—And this one (9)? P.—Lower jaw-bone. T.—What are set in these jaw-bones? P.—The teeth.

In our next lesson we will learn about the bones of the trunk. How many will find out all you can about them? (Hands up.) Very well; I shall see what you can tell me to-morrow.

EXERCISE IV.

SKELETON PLATE.

T.—What is this part of the body called? P.—The trunk. T.—In this group are 55 bones. Its shape, especially in the upper part, seems to show that it is intended to contain some important inside parts of the body. Will any one name some part of the body which you think is enclosed by these bones? P.—Heart, lungs. T.—These important organs are inside the upper part of the trunk. This part of the trunk is called the chest. In the lower part are contained the stomach, liver and other organs. This part is called the abdomen. Now, let us see how this trunk is put together.

Look at this long pillar of bones at the back. What do you call this? P.—The backbone. T.—Correct. It is also called the spine. What do you notice at the upper end? P.—The head rests on it. T.—Yes; what do you see at the lower part of it? P.—Large bones fastened to it. T.—What do you notice about its middle part? P.—There are many bones fastened to it. T.—How many of you think that this backbone is all one bone? (Some hands go up.) T.—How many think it is made of more than one bone? (Other hands rise.) T.—It is made of 26 bones. Can any one tell me why this is better than if it were made of only one bone? (Hands up.) T.—Well, Laura, what do you say? Laura—I think it makes the back stronger. T.—You are right, Laura. George, what more do you think about it? George—We could not bend the back if it were all one bone. T.—Very good. Each one of these bones in this pillar is called a *vertebra*. I will write it on the board. V-e-r-t-e-b-r-a. All name it. Now, I wish you to notice another thing about this backbone. These *vertebrae* you see do not rest directly upon each other. There are cushion-like bodies of material softer than bones placed between them. This makes it easier to bend the back and also prevents the bad effects of heavy jars to the body.

T.—What are these long curved bones? P.—Ribs. T.—Yes. What is this part between the head and the ribs? P.—The neck. T.—Right. There are seven bones in the neck. Are the ribs alike on both sides? P.—Yes. T.—So we say they are in pairs. Let us count them. (Teacher points to the ribs (16) from top down, while pupils count.) Twelve pairs. T.—Do you notice any difference in these ribs? P.—Yes. T.—What do you see? P.—Some are loose at one end. T.—Are all attached behind? P.—They are. T.—To what are they united? P.—To the backbone (spine). T.—What name would you give this (15) bone? P.—Breast-bone. T.—Very good. Now, how many pairs of these ribs are joined to this (15) breast-bone? (Teacher points out those which have direct union, while pupils count.) Seven. T.—These seven pairs are called true ribs. Here are one, two, three pairs, whose ends do not come up to the breast-bone; but they are united to each other and to the seventh true rib. These three pairs are called false ribs. Now, how many pairs are altogether loose in front? P.—Two. T.—These two pairs are called floating ribs.

T.—These (27) large, flaring bones make a broad, bowl-shaped support for the contents of the lower trunk, or abdomen, and a firm place of attachment for the bones of the lower limbs.

Now, let us see what we know about the trunk. How many bones in the trunk? P.—Fifty-five. T.—What important organs are contained in the trunk? P.—Heart, lungs, stomach, liver, and others. T.—What is the upper part of the trunk called? P.—The chest. T.—The lower part? P.—The abdomen. T.—On what strong pillar of bones does the head rest? P.—On the spine (backbone). T.—How many bones in the spine? P.—Twenty-six. T.—Do these rest directly on each other? P.—No. T.—How are they united? P.—There are cushions of softer material placed between them. T.—What is each one of these bones called? P.—A *vertebra*. T.—Susan, please write that name on the blackboard. How many pairs of ribs? P.—Twelve. T.—How many pairs of true ribs? P.—Seven. T.—To what are the true ribs attached in front? P.—To the breast-bone. T.—What are the next three pairs called? P.—False ribs. T.—Why should these (27) bones be so large? P.—To support the organs in the abdomen and give a firm attachment to the bones of the lower limbs.

EXERCISE V.

SKELETON PLATE.

T.—What do we call the upper limbs? P.—Arms. T.—Most of these are long bones; but this one (14), which I wish you to notice first, is a broad flat bone. It is commonly called the shoulder-blade. To this strong bone you see the arms are connected. This (13) pair of bones is called the collar-bones. I give you the common names now. At the proper time hereafter you will learn the scientific names. T.—Against what bone does this (13) collar bone rest at this end? P.—Against the breast-bone. T.—Right. At the other end you see it rests against the shoulder bone. Now, how many of you have any idea what this bone is for? (Hands up.) T.—Harry, what is your idea? Harry—It braces out the shoulder and arms, and keeps them from falling in toward the breast, or resting too heavily on the chest. T.—That is a very good answer, indeed. Now, grasp firmly with your hand your upper arm. You feel this (19) bone. Perhaps you would like to know the name of this prominent bone. It is called the humerus. It is written so: (on blackboard) h-u-m-e-r-u-s. T.—What is this joint at its lower end? P.—Elbow-joint. T.—How many bones do you see in the fore-arm? P.—Two. T.—What is this (22)? P.—The wrist. T.—The wrist is made of eight small, roundish bones. How many do you see in the middle hand (23)? P.—Five. T.—In the fingers we have three bones to each finger and two for the thumb. So, how many finger bones in each hand? P.—Fourteen.

T.—Now, let us pass to the lower limbs. What do you notice about this bone (32)? P.—It is the biggest bone in the body. T.—Yes, the largest and the strongest; so I am sure you will want to know its name. It is called the F-e-m-u-r. Notice how its smooth, round upper end (30) fits into the cup-like socket in these (29) bones of the trunk. This is called the hip-joint. What is this joint called? P.—The knee joint. T.—Over this joint you see this (33) roundish bone, commonly called the knee-pan. It adds strength to the knee joint. How many bones in the lower leg? P.—Two. T.—What difference do you see in them? P.—One is a large, strong bone, and the other is very slender.

T.—Now, we come to the foot. What is the back of the foot called? P.—The heel. T.—There are seven bones in each heel, five middle bones in each foot, and just as many toe-bones as finger-bones. So, how many toe-bones in each foot? P.—Fourteen.

T.—Let us now review the lesson. What is this (14) bone called? P.—The shoulder-blade. T.—Why should it be so strong? P.—Because it supports the arms. T.—Name this (13) bone? P.—Collar-bone. (Draw out by questions its use.) T. What is this (19) large upper bone called? P.—Humerus. T.—How many bones in the fore-arm? P.—Two. T.—In the wrist? P.—Eight. T.—In the middle hand? P.—Fourteen. T.—What is the largest bone in the body called? P.—Femur. T.—How many bones in the heel? P.—Seven. T.—In the middle foot? P.—Five. T.—In the toes of each foot? P.—Fourteen. Now, we have had three lessons on the bones of the skeleton. In our next lesson we will make a thorough review of what we have so far learned.

EXERCISE VI.

SKELETON PLATE.

Let this exercise be made a thorough review of the three preceding skeleton lessons. If necessary to fully and clearly impress the facts learned, spend several recitations on this exercise.

To the Teacher.—In the preceding exercise on the skeleton, we have given you very minute suggestions as to the manner in which you may impart to and draw out from your pupils the elementary facts of this study. We recommend that you pursue the method which has been indicated throughout the whole course of lessons. In general, hereafter, the anticipated answer of the pupils will be made a correct answer. If the pupils' actual answers are incorrect, and you can not, by restating or reshaping your questions, draw out the right idea, then state it correctly in your own best words, requiring its proper reproduction by the pupils in the review. Hereafter the pupils' answers to review questions will not be indicated.

EXERCISE VII.

MUSCLES, VEINS AND ARTERIES.

Now we come to a new part of this study. I wish you all to notice carefully the difference in appearance between the figure on this plate and the figure of the skeleton. What do you discover about it? Maggie—It looks more like the real body. Harry—The bones are all covered up. George—There are lots of tubes and thread-like things running through it.

Teacher—Very well; your observations are all good. We will now study these organs of the body which are represented on this plate by these red-colored parts. These represent the muscles. All the muscles taken together make up what is called the muscular system. By this word system we mean, in Physiology, all those parts or organs of the body which work together for the same general purpose. So what system have we been studying? Pupils—The bony system. T.—And what name did we give to the whole of the bony system ? P.—The skeleton. T.—You have the idea. Now we will study the muscular system. When you get meat from the market for food, which part do you use for that purpose. P.—The flesh which surrounds the bone. T.—Yes ; that is what we really call meat. What is its color? P.—It is generally red. T.—Correct. Now, this red or lean meat of animals, which we use as food, is muscle; so we may say that the muscles are the lean meat of the body. Mary, what have you noticed about the meat on the breast-bone of a chicken at your dinner table? Mary.—It is nearly white. T.—Right. Not all muscle is red, but it is generally red. Now, to what is the meat or muscle attached? P.—To the bones. T.—The muscles are attached to the bones for the purpose of moving them. Now, learn carefully the explanation I am about to give you. I will make it as simple as possible.

These muscles (referring to the plate) are made of many strings or fibers, something like a skein of yarn. You can see these strands or muscle threads in a piece of beef that has been cooked very tender. Such a piece may be pulled apart into string-like fibers. How many of you have ever noticed this? How many of you will try to find these muscle fibers when you have an opportunity?

Now, these muscles or threads of the muscle have the power of shortening up lengthways and swelling out sideways. What effect would that have on the whole of the muscle? Harry—It would shorten the muscle. T.—Very good. Now, if such a muscle is fastened at its two ends to different bones, what will happen when the muscle shortens up? Laura—It will move the bones. T.—That is the idea. All the movements of the body from the very slightest to the very strongest are produced by the muscles.

How do muscles produce such motion? P.—By shortening up and pulling on the bones. T.—How do you suppose a bone gets back to its first position? Laura—I suppose that the muscle which pulled on it by shortening must lengthen out again, and some other muscle by its shortening up pulls the bone back again. T.—Very well, indeed, Laura. Now, I think we are all able to learn the names of these two kinds of action in the muscle. Its shortening up is called *contraction*, and its lengthening out is called *relaxation.* I will write these two words on the board while you fix them in your memory. Now, we will gather up what we have learned about in the lesson. What parts of the body have we been speaking about? What system of the body do they compose? What part of the animal body is called muscle? What is its usual color? To what are the muscles attached? For what purpose? How do the muscles move the bones? What is meant by the contraction of a muscle? By its relaxation? In our next exercise we will study the action and use of some of these muscles shown on this plate.

EXERCISE VIII.

MUSCLES, VEINS AND ARTERIES.

Since we have learned what the muscles are for and how they act, we may now get a still better idea of the working of this system by a study of the use of a few of them. There are about 500 muscles in the body. Let us look at this [1] one. Only its front part is shown on the plate. It is fastened behind to the occipital bone. [Test their memory on this bone.] It passes over the head forward, to the skin of the forehead. Now, being fastened to that firm bone behind and in front to the skin of the forehead and eyebrows, what effect do you suppose its shortening up [contraction] would have? Charles—I think it would raise up the eyebrows. Mary—I think it would also move the skin on the forehead. T.—You are both right. Now, you will all be delighted to see how easily we can make this muscle show us how it acts. [Teacher illustrates on his own face the raising of the eyebrows and wrinkling of the forehead. Pupils can easily imitate this.]

I see you are all pleased with this experiment on this muscle. The muscles, like the bones, have different names given them by physiologists. They are generally named according to their place or shape, or the kind of motion they produce. Most of these names are very hard. I will give you just this one name of this (1) muscle as a specimen. It is called the *occipito-frontalis*, a double name, you see. I wonder how many of you could give me a reason why this muscle should be called the *occipito-frontalis*. [Hands up.] Well, Harry, what do you say? Harry—Because it goes from the occipital bone to the front part of the head.

T.—Very well, indeed. Now, all look at this (2) muscle. What do you notice about its shape? P.—It is round, like a circle. T.—What do you notice about its place? P.—It passes around the eye. T.—Correct. Now, what would be the effect of its contraction [shortening]? P.—It would close up the eye. T.—That is exactly its work. Do you see any other muscle of the same shape anywhere? [Hands up.] Tell me where, Nellie? Nellie—Around the mouth (5). T.—What must its use be? P.—To close the lips. T.—Now, let me try one more experiment on the muscles. Let us take this strong muscle (10) of the arm. Hold your left arm out straight. Now, grasp it firmly with your other hand a short distance above the elbow. Now, draw your fore-arm up towards your shoulder. What do you feel?

George--I feel my arm swell out where I hold it. [Let all the pupils be sure they feel the swelling of the muscle.] T.—Now, what have we learned to be the effect on a muscle when it swells out sideways? P.—It becomes shorter. T.—Right; and in so doing, what does this muscle of which we are speaking do? P.—It pulls the arm up towards the shoulder.

T.—Bring your arm up towards the shoulder once more. Grasp it firmly as before. Now straighten the arm. How many of you feel the swelling out of a muscle on the back of your arm? [Hands up.] That was the contraction of this [11] muscle. Its use is to bring the fore-arm back into a straight position.

This will he sufficient to give you a pretty clear idea how the muscles work. I will close this exercise by simply asking you to notice well, on this plate, these strong muscles of the neck [7, 8]; of the shoulder and arms [9, 11, 14]; of the lower limbs [16, 17], and of the foot [20].

To-morrow we will learn about the proper care of the muscles. Find out all you can about it, by thinking, reading, and talking it over at home.

EXERCISE IX.

CARE AND USE OF THE MUSCLES.

As we proceed in this study of Physiology, learning many things about the structure and use of the different parts of the body, it is very important that we should also learn something about the proper care of these organs. Our health, and consequently our lives, depend upon such care. Every organ of the body is subject to injury from misuse: too much use, or too little use. For instance [turning to skeleton plate], notice the natural shape of the backbone. Now, what must be the consequence of sitting much in a position bent over? What do you suppose results from much daily exercise in walking? P.—It strengthens the muscles of the lower limbs. T.—Yes. Now, suppose I should let my arm hang steadily by my side for a number of weeks, what would be the consequence? P.—It would become very weak. T.—On the other hand, if I use it too vigorously, or too long, is would also fail in strength. That kind of play, exercise or labor is most healthful which calls into use the moderate action of the greatest number of muscles. The strong muscles of the robust laborer come from a general use of his limbs and his trunk. [Refer to the variety of work engaged in by the farmer. Develop the idea that because his muscles are all exercised, he is the stronger in his whole body than other men. After this manner bring to bear on the minds and memory of your pupils these important hygienic principles. Get back from them what you have given them in this lesson by a thorough review drill.]

EXERCISE X.

MANIKIN—THE HEAD.

We have learned about the bony framework or skeleton of the body. We have also learned about the muscles which cover the skeleton and move its different parts. We will now pass from the framework and its cover of muscles to the study of some of the important and wonderful organs and systems inside. Let us begin at the head. You will be surprised to see how this arrangement on the study will enable you to learn what is in the head. What do you observe as an outside covering of the head? [The hair and the skin.] Now, let us take off, as it were, these outer covers. [Turn back outer section.] What have we here? [Bones and muscles.] [Let them identify the three skull bones whose names they have previously learned.]

These blue, red and white lines [18, 19, 21] are blood-vessels and nerves, of which we shall soon learn more. Now, let us take off these bones, muscles, blood-vessels and nerves. [Lay back the section.] Now, you see here lies what organ? [The brain.]

Notice how it fills the whole upper and back part of the head. Observe well the folds on its surface. The brain is a soft, pulpy body, of a whitish color. It is the chief organ of the nervous system of the body. I will try to help you understand something about the use of this system. What did we learn to be the use of the muscles? [To move the different parts of the body.] Now, the mind has a very curious way of telling the muscles when to act. You notice here and have noticed before many of these white thread-like lines [38] running through the whole body. These are called nerves. They go to all the muscles. At the other ond they are in connection with the brain as we shall soon see. Now, for instance, I make up my mind to raise my fore-arm. The brain sends out a message over the nervous lines, which go to this muscle [front upper arm], ordering it to contract. Promptly it obeys and up comes the arm. In this way the nervous system carries our messages to the muscles of any part which is to be moved. Notice, however, that there are some parts of the body which must keep up their work every moment of our life. For instance, the heart and the lungs. So the brain keeps the muscles of these parts at work all the time. Besides the nerve lines which go to the muscles, there are others which come to the surface of the body in the skin. Now when any part of the body is injured, or merely touched, these nerves at that place carry a message to the brain, and this we call feeling. You see how much these nerves are like telegraph lines. [Give them an idea of the great number and distribution of these nerves by asking them whether they could touch the skin anywhere with a pin without feeling it. At every point a nerve is touched. The nerves which carry messages out from the brain to the muscles are called nerves of motion. Those which carry messages to the brain are called nerves of feeling. Let me make this still plainer to you. Suppose you accidentally touch a hot stove with your hand, quicker than a wink the nerves report the trouble to the brain, and just as quickly the brain sends out to the muscles of the hand a message to move it away. [Produce other illustrations.] Whenever we feel pain, the brain is receiving messages of distress over the nerves from the troubled part of the body.

[Thoroughly review this lesson.]

We will have another exercise on the nervous system to-morrow.

EXERCISE XI.

MANIKIN—THE HEAD.

Let us see how the nerves branch out from their great center the brain. Before we pass to another section, notice that there are really two very separate parts of the brain. We sometimes speak of this [27] as the large brain, and this [28] as the little brain. Now, notice this large cord [30, 29] of nerve matter passing down from the brain out of the head. Let us trace this farther. [Turn to last section.] Here we have the head and neck shown as cut through in the middle. Half the brain lies before us. Here, again, is this [29] nerve cord. See how it passes down from the brain through the bones of the spine. So we call it the spinal cord. It extends the whole length of the back, and from it branch out many nerves to all parts of the body. Let us notice some of these nerve branches. Here [46], for example, is the nerve branch which goes from the brain to the nose. [Turn back one section.] Here [33] is the nerve which goes to the eye. This nerve [38] branches to the teeth. [Turn back one section.] What do you notice about these nerves? [White lines.] [They spread over the head and neck.] Now, let us turn back to a full body plate. [Second plate.] Here you get a general view of the distribution of nerves. See how they branch off to all parts—head, neck, arms, trunk and lower limbs.

We can easily understand why this delicate nervous system needs the very best of care. In all our waking moments it is kept at work, and some parts of it, as you have learned, must work, whether we are asleep or awake. But the brain must have seasons of rest as regularly as the body needs food. Sleep is the natural rest of the brain. During active waking hours the brain suffers wear; during sleep it undergoes repair and acquires new vigor.

[Thoroughly review this lesson.]

EXERCISE XII.

MANIKIN—HEAD AND BODY.

The body is subject to constant wear and waste. Any motion of any part, however slight, wears out its material and produces waste. Even our thinking wears on the body This wear must be repaired; the waste matter carried off and replaced by new material.

While the body is growing, the supply of building matter must be greater than the waste. Now, from what do you think this supply of material for the repair and building of the body comes? [From the food we eat.] What liquid in the body carries it to every part? [The blood.]

The separation of the useful from the useless parts of food in the body is called digestion. [Spell,write and impress this word.] Let us see what we can learn about the process of digestion. First, the food is taken into the mouth [52]; chewed by the motion of the jaws and tongue [53], and grinding by the teeth. While being chewed it is mixed with saliva from organs, one of which you see under the tongue here [54]. In swallowing the food it passes down through this [57] tube into the stomach. We will find this important organ elsewhere on this study. [Turn to Manikin of the Body on reverse side of this Study, unfold the section until you have laid bare the stomach]. Here [54] you see this tube leading down into the stomach [46]. This shows the inside of the stomach. [Lay back another section]. Here we have the outside view of the stomach. Notice particularly its place in the body. In the stomach the food is much changed. [Return to the last moved section.] From the stomach it goes out into the intestines here [47]. Here it is still more changed by being acted upon by two substances. [Unfold all the sections.] One of these two substances comes from this [65] organ lying back of the stomach, called the pancreas. The other substance, called bile, is furnished by the liver. (Close up stomach and liver sections.) Here lies this large organ—toward the right side of the body over the stomach. (Raise outer liver section.) Observe the large blood vessels and the bile sac [40] within it.

So here, in the upper part of the intestines, the useful part of the food is finally separated from the useless part and is drawn from the intestines by little vessels which carry it into the blood.

Now, let us see how well you have learned this exercise [Review.]

EXERCISE XIII.

BLOOD CIRCULATION.

We have a new and very interesting and instructive plate before us. We will now learn how the blood circulates through all parts of the body, carrying with it the material prepared by the organs of digestion for body building and repair, and gathering up waste matter and impurities. When the nourishing portion of the food is taken from the upper part of the intestines, it is carried into this [29] tube, which carries it up, you see, and pours it into this [15] large blood-vessel, which again carries it on [14, 13] to the heart [25]. [Call attention to the two sides of the heart.] The right side of the heart [left in the figure] is represented dark because it contains dark, impure blood; the left side light because it contains red or pure blood.

The blood-vessels which carry blood away from the heart are called arteries. [Refer to the name on the plate index.] Those which carry blood to the heart are called, veins. [Explain which are shown red and which blue, and why.] Now starting with pure blood from the left side of the heart, this [4] large artery which leads away from the heart, branches off into smaller arteries, through which the blood is carried to the head, arms, trunk and all other parts. These arteries again branch off into very small, still finer tubes (capillaries), from which, along their course everywhere, new material is given to the body from the blood, and old, worn-out material is gathered into the blood making it dark and impure. These very fine tubes, as you see, gather together into veins, and these, growing larger and larger, bring the blood through these two very large veins (13, 18) back into the right side of the heart.

So we have traced the blood from the left side of the heart through the body, and back to the right side of the heart. From here we will pursue it farther in our next lesson.

(Drill your pupils on this until they can give it back to you step by step.)

EXERCISE XIV.

BLOOD PURIFICATION.

In our last lesson we learned about the course of the blood through the body. What change is made in it in this course? (Loaded with impurities.) In this impure condition we left it where? (In the right side of the heart.) What seems necessary to be done before it goes through the body again? (It must be purified.) Let us learn how this is done.

From the heart the blood goes through this large artery (5) to the lungs. These you see here in two lobes—one on each side of this study. (Turn to body Manikin on reverse side of the Study. Lay bare the lungs.) Here (19, 20) we see the lungs in their actual position. Notice their light, spongy appearance. Lay back this outer section.

Here (23) lies the heart. (Lay down the section before you.) This shows us the arteries (blue) which bring tho blood into the lungs from the heart, and the veins (red) which take it back from the lungs to the heart after it is purified. (Turn up the section last laid down.)

At every breath we draw, air passes into the lungs. How does it reach the lungs? [Through the mouth, then through this tube (33) called the windpipe, then on through these numerous air-tubes (21,) into all parts of the lungs.]

Here, in the lungs, the oxygen of the air unites with the blood. At the same time the impurities of the blood pass from it into these air-tubes, and are thrown off with the outgoing breath. In this way the blood is rid of its impure matter, changed from its dark color to a bright red, and now is again fit to be driven by the heart to all parts of the body. (Turn to third plate.) The blood is now carried from the lungs through these (17) veins into the left side of the heart, again to make the round which we have learned before. Has any one of you a question to ask on what I have just explained? (encourage questions at all times.)

By what act is air carried to the lungs? [By breathing.] In breathing the muscles expand the chest to draw air into the lungs, and contract it to force the breath out. Anything which interferes to prevent taking in full breaths of air is injurious. Why? Compression of the chest by too tightly-fitting garments must have this effect, and should always be avoided. In the lungs, the life-giving oxygen is taken away from the air. To the unused portion of the air are added the impurities discharged from the blood in the lungs. (Show the consequence of this foul, cast-off breath accumulating in a room without sufficient supply of pure, fresh air. Impress thoroughly and illustrate well, from your own knowledge and in your own way, the important principles of good ventilation. Then make a good review of this important lesson.)

EXERCISE XV.

BLACKBOARD OUTLINE REVIEW.

Having now learned something about each of the great systems and processes of the body, it is suggested that the teacher make this exercise a blackboard outline review. By careful questioning, draw out from the pupils the leading facts learned about each system and arrange them on the board in some such form:

- THE BONY SYSTEM. (Skeleton.)
  - Composed of Bones.
    - 208.
    - Long, flat, curved, etc.
    - Three Groups.
      - Head.
      - Trunk.
      - Limbs.
  - Use.
    - To give shape to the body.
    - To enclose and protect delicate organs.
- THE MUSCULAR SYSTEM.
  - Composed of Muscles.
    - Lean meat.
    - Many fibers.
    - Power of contraction.
    - Attached to bones.
  - Use.—To move the different parts of the body.
- THE NERVOUS SYSTEM.
  - Composed of
    - Brain.
    - Spinal Cord.
    - Nerves.
  - Uses.—
    - To serve the mind and brain in the control of the action of the muscles.
    - To give us sensation of touch, pain or feeling.

Request the pupils to bring you their reproductions of this outline, as well as they can make it, on paper. The next exercise should be preceded by comments upon the pupils' reproductions of this one.

If considered desirable, an outline exercise of this kind may be made of each of the preceding synopses. The teacher can extend the scheme according to his judgment.

EXERCISE XVI.

OUTLINE REVIEW CONTINUED.

- THE DIGESTIVE SYSTEM.
  - Composed of
    - Mouth.
    - Teeth.
    - Tongue.
    - Stomach.
    - Liver.
    - Intestines.
    - Other organs.
  - Use.
    - To separate from the food the portions which are useful for building and repairing the body.
- THE CIRCULATORY SYSTEM.
  - Composed of
    - Heart.
    - Arteries.
    - Veins.
    - Capillaries.
  - Use.
    - To carry the blood to all parts of the body.
- THE BLOOD-PURIFYING SYSTEM
  - Composed of
    - Lungs.
    - Windpipe.
    - Air Tubes.
  - Use.—To purify the blood.

EXERCISE XVII.

MANIKIN—THE BODY.

If the lines of work hitherto suggested have been well performed, the teacher will now find an excellent opportunity for a general review of the lessons, as well as for a general view of the body, in the study of this Manikin. Now, the teacher should expect from his pupils a prompt identification of the parts of systems as they appear in this Manikin dissection. Where parts appear which are not yet familiar to the pupils, give such instructions as may be needed.

With the other section before you, the pupils will promptly recognize it as representing the skin. Give them an idea of its structure—outer skin and true skin. Outer skin is shown in the raising of a blister. No feeling in it because there are no nerves there. Protects the true skin. The true skin contains blood-vessels and the ends of many nerves of feeling. Contains also sweat pores, oil tubes and the roots of the hair. This gives opportunity to show the necessity of clean lives; enforce this hygienic precept strongly. Now, let us remove the skin from the body. (Lay back outer section.) What system is prominently shown here? [The muscular system.] Draw out by question that these (1, 2) are muscles of the neck; (3) of the shoulder; (4, 5) of the chest, shoulder and arm; (6) of the chest; (7, 8) of the abdomen; (11, 12, 13, 14, 15) of the lower limbs.

Now, we will remove this coat of outer muscles. (Turn section.) What system appears here (17)? [The bony system.] What are these (17)? [The ribs.] This bone (16)? [The breast-bone.] And between these ribs (18)? [Muscles.] (Lay back rib section.) What appear here (19, 20)? [The lungs.] In what process of the body do they serve? [In purifying the blood.] Lay back outer lung section. What are these (21)? [Air-tubes in the lungs.] This organ (23)? [The heart.] To what system does it belong? [Circulatory system.] What does this (26) represent? [One of the large veins leading into the heart.] Does it carry pure or impure blood? [Impure blood.] (Turn down section.) Explain that here are shown blood chambers and valves inside the heart. The pupils will recognize these (34) as arteries and veins in the lungs.

Review in reverse order to the surface.

EXERCISE XVIII.

(Lay bare the liver.) How would you state the position of the liver? To what system does it belong? (Digestive system.) What substance does it prepare for the process? [Bile.] Explain that the liver makes this bile out of impure blood, and for this purpose is well furnished with blood-vessels. (See inside section.) (Turn to stomach.) Question about its position and use. Get from the pupils the name "intestines," and to what system they belong. Turning to next section, see if the pupils will recognize the lines on the stomach as blood-vessels. (Pass to last full section.) We have now penetrated to back part of inner body. Here lie a few more special organs, as the Pancreas (65,) the Spleen (66) and the Kidneys (68). What are these large blue vessels (63)? These large red ones (55)? Do you recognize this tube (54)? [The tube through which the food passes into the stomach.]

Let the pupils identify the name, as you point out on plate, sections of bones of shoulders, ribs, hip-bones, and upper part of femur, muscles of neck, shoulders, between ribs, lower body and limbs.

Now replace the sections, letting the pupils name the parts as they are placed in position.

EXERCISE XIX.

MANIKIN—THE EAR.

Let the teacher, in a familiar way, teach the pupils the names of the five special senses, in this order: Feeling, Tasting, Smelling, Hearing, Seeing. Let some pupil write them on the board. Now explain that we have the sense of feeling whenever the nerves of feeling are found. Then, from what has been learned. draw out the conclusion that this is all over the body. For tasting we have the special nerve of the tongue. For smelling we have a special organ, the nose; and a spécial nerve, the nerve of smell. For hearing and seeing we have not only special nerves, but also very delicate special organs, which we will now proceed to study.

Let us first learn about the ear and hearing. Here is a figure of the outside ear. When a sound is produced, the air all around the sounding body is thrown into motion. This motion of the air we call sound waves. Now, you see, the ear, shaped as it is, catches some of these sound waves, that is, they pass into the ear. Now, to understand what happens farther to these sound waves, let us look into the ear. (Turn back outer section.) Here, after passing through a short tube in the outer part of the ear, the sound falls upon this (2) little sheet or membrane, which on account of its likeness to a drum-head is called the ear-drum. Now, what happens when a drum is struck with a drum-stick? (Pupils' answer will be: sounds.) Yes. What else does the drum-head do while it sounds? [Trembles—vibrates.] So when the sound waves of the air strike upon this (2) ear-drum, it is made to tremble or vibrate. Now, let us look still farther into the ear. (Reverse side of this section). Here (3) we have the inside surface of the ear-drum, and resting against it is the first of a chain of three little bones—one shaped like a hammer, the second like an anvil, and the third like a stirrup. Now when this (3) ear-drum is made to tremble by a sound wave, it jars this little chain of three bones. (Next section.) Now, we see a curious double set of tubes. This (8) on the right is shaped like a snail shell. The little chain of bones carries the sound into these tubes, and here it reaches the nerve of hearing which carries it to the brain, where the mind perceives the sound, and we call it hearing.

EXERCISE XX.

MANIKIN—THE EYE.

What have we learned affects the nerve of hearing? Sound. What have we found to be the use of the ear? To collect sound waves and carry them to the nerve of hearing.

As the nerve of hearing is affected by sound what do you suppose affects the nerve of sight? [Light.] State that the nerve of sight is not at all affected by sound nor the nerve of hearing by light. (Lay open two sections of the head above.) Here (33), you remember is the nerve of sight. What did you say affects this nerve? [Light.]

Now, as the nerve of hearing needs such an organ as the ear to help it receive sound impressions, so this (33) nerve of sight needs a special organ to help it receive impressions of light. What is this (31) special organ called? [The eye.] Let us see how it is formed. (Close head sections.)

Here we see the eye as it appears in the head. What is over it? [Eyebrows.] What do you see around the eye? [Eyelids.] Draw out the idea that these are for the protection of the eye.

Now, how many parts of the eyeball do you see? [Three.] The white part is the outside coat of the eye. It does not let any light through it; but the middle front part of the eye does let the light through it into the eyeball. Let us remove the outer coat.

What does this (4) represent? [A part of the muscles of the eye.] Here (1) is where tears are formed. (If you prefer, explain that the liquid formed is intended to keep the surface of the eye moist, and that it is only when it gathers in large quantity and runs over that we speak of it as tears.)

Let us turn to the next section. Here (8) are parts of the muscles which move the eyeball up, down or sideways. You see these blood-vessels branching out over it. Through the opening which you see in the center of the eyeball, and which you can see by looking into another person's eye, the light is passed into the inner portion. (Next section.) This opening is called the pupil of the eye. This circle (11) which you see around the pupil is made of very delicate little muscles, which act so as to make the pupil larger or smaller, according to the strength of the light. State that this is gradually done, and draw on the pupils' experience in going from a bright light into the dark or *vice versa.*

(Turn to the last section.) When the light coming from anything we are looking at has passed through the pupil and several other parts in the eye, it finally makes a small picture of the object on the back, inner part of the eyeball, where the nerve of sight is spread out (15) as you see. This nerve, affected by the light which produces this picture, carries the impression to the brain, where the mind receives it and we call it seeing.

EXERCISE XXI.

CRANIAL, SPINAL AND SYMPATHETIC NERVES.

We have already, in the course of our study, learned something about the Nervous System. This is such an important part of our bodies, and at the same time so difficult to understand from the description of the books, that a special plate or map of it is here furnished us. It will be well for you to learn right here, that it is this great Nervous System that makes the life of an animal so different from the life of a plant. Both plants and animals, you know, are *living* things, and quite similar, in many respects, in their modes of life. They both have feeling, breathing and circulating systems but the power to move themselves and the ability to feel, which animals possess and plants do not, comes from the possession and use of these nerves. In the human body this system is most perfectly constructed. (Here the teacher should recall by review the divisions of Brain, Spinal Cord and Nerve Branches. Also what has previously been learned about the use and manner of action of the nerves, and their likeness to telegraph wires connecting the brain with all organs and parts of the body.) These numerous nerve lines of the body belong to three great groups or divisions—namely, the Brain group, the Spinal group and the Sympathetic group. Here, at the top of this wonderful part of the structure of the body, is the Brain. It may properly be called the capital of the Nervous System where the mind issues its orders of control over the body and receives its impression from the outside world.

This large, upper division of the brain is called the *Cerebrum.* It is found to be chiefly concerned in our thinking and sensations. This smaller, lower division is called the *Cerebellum.* It serves to direct and harmonize the movements of the body. Then here, as a sort of connecting organ between the Brain and Spinal Cord, is the *Medulla oblongata.* This is the headquarters of those important nerve lines which go to the heart, lungs, stomach and other prominent organs. Now, we have here a fine view of the branching of the nerve lines from the Spinal Cord. There are thirty-one of these spinal pairs or branches. Eight pairs branch from the neck region (Cervical). Twelve pairs go out from the back (Dorsal). Five from the loins (Lumbar). Six proceed from the lower part of the back (Sacral). These, by their crossing and recrossing, and apparently, but not really, uniting and dividing, form groups, each of which is called a *plexus*, as you see them indicated on this plate.

This second figure shows us beautifully how the nerves are distributed. There are twelve very important nerve pairs which start from the brain. These are the cranial nerves. They include the special nerves of smell, sight, hearing and taste and other prominent nerve lines. They generally take their names from the organ with which they communicate. There (F), for instance, is the Olfactory nerve which, you observe, goes to the nose, to receive and convey the impressions of odor. This (G), the Optic nerve, goes to the eye to receive the impressions of light, while this (H), which also goes to the eye, controls the motion of this organ. In this way follow the distribution of these cranial nerves, and show (K) as illustrating the head branches of neck (cervical) nerves. Point out and describe the Sympathetic System as composed of two chains of nervous knots (little brains)—one on either side of the spinal column—bringing the great vital organs of the body into communication with each other and with the brain, making it possible for all members to sympathise with a suffering member. Example: A sick stomach and an aching head, etc.

EXERCISE XXI.

MICROSCOPIC VIEWS.

Blood and Blood Corpuscles.—When we look at blood with the naked eye, we see nothing but a rather thick, bright red liquid. Its appearance gives us no idea whatever of the various and wonderful parts of which it is composed. But now the microscope comes to our assistance and shows us that every drop of this life-stream, making its ceaseless rounds to and through all parts of the body, consists of a large number of very small red particles called *corpuscles* floating in a thin, colorless liquid called *plasma.* This figure (chart) represents a dozen or more of these corpuscles as they appear in warm blood when examined with a microscope. Notice that they are flat and circular in shape. This is not the case with the blood of all animals. In the blood of birds for instance, these corpuscles instead of being circular, are longer than wide (elliptical.) Thus, while we could not tell with our naked eye a drop of man's blood from a drop of bird's blood, the microscope quickly reveals the difference. It has been estimated that no less than five millions of these red globules are contained in a very small drop of blood.

Besides these red corpuscles there are also white ones like this here represented (chart) floating in the colorless liquid of the blood. But these are much fewer in number than the red globules.

Let us now try to learn what service these different parts of the blood render. We have just learned that the two parts of the blood are the *corpuscles* and *plasma.* The corpuscles are solid, the plasma is a liquid in which the corpuscles float. This liquid contains in solution (teacher explain "solution") the useful parts of food which are to nourish and build all parts of the body. The corpuscles carry the oxygen taken up from the air in the lungs, as we have learned before, and convey the quickening and purifying element to every point in the system, to carry off, or, rather, burn, the waste or worn-out material of the body.

EXERCISE XXIII.

The Capillaries.—In a former lesson we have learned that in the circulation of the blood it flows from the heart to the various parts of the body through the *arteries*, and that the impure blood flows back to the heart through the *veins*. But the arteries do not directly connect with the veins. Between these larger blood channels is a system of blood-distributing vessels so numerous that you can scarcely prick any part of the body without striking one or more of them and causing the blood to escape. These connecting channels between the arteries and veins are altogether invisible to the eye. But the microscope shows them in the clear manner represented in this figure on the chart. These red vessels (A) represent the arteries carrying the pure blood loaded with food material and oxygen. Now the stream divides into a thousand tiny streamlets flowing through the capillary tubes. From these capillaries the building cells of the body take up from the blood the material they need. In exchange for this new material there are thrown into these tubes worn-out particles. Now comes the oxygen and seizes this waste matter and moves on with it into the veins shown here by these blue vessels (B). These carry their impure blood back to the heart whence it goes to the lungs, where the impurities are thrown off with the breath, and the blood is charged with a new supply of oxygen and started off on a new round of circulation. This figure (chart) shows the connection of arteries, capillaries and veins in the lungs.

EXERCISE XXIV.

Structure of Bone.—We have learned that every part of the body, whether flesh, nerve, hair or bone, is built from material furnished by the blood. Looking at an ordinary bone it appears quite solid, and seems difficult to understand how the blood-vessels can reach all its parts to furnish it with the needed nutriment. Here again the microscope comes to our aid to solve one of nature's countless problems. This diagram (chart) shows you how a section of bone sawed lengthwise looks when much magnified. Instead of being really solid, the bone is seen to be full of little spaces or canals communicating with each other and with much larger canals. These larger canals are shown very clearly in this figure. Notice that a blood-vessel passes through each. From these blood-vessels the material suitable for bone growth is gathered and carried through the small cavities and very fine tubes to every point where it is needed.

Valves in the Veins.—We have just learned how the capillaries, like numerous little rivulets, gather the blood into the veins. The smaller veins, like creeks, unite in a few larger rivers of blood flowing as into a gulf in the right upper chamber of the heart. Now, in the flow of blood through the veins, there would be danger of its setting back or flowing in a contrary direction, which might prove fatal to life. To prevent such an occurrence, we find in the veins a system of valves which are well represented in this figure. These valves are like pockets. This shows the vein as laid open in halves. If you will now examine these two halves or sides to be brought together, you will understand how pocket like these valves are. They permit the blood to flow through them easily in the proper direction, but prevent its flowing backward. You can easily see why the veins in the lower limbs, where the blood, in going toward the heart, must go directly against its weight, should have more of these valves than are found in *some other* parts of the body.

EXERCISE XXV.

Structure of Hair and Nails.—One would hardly suppose that such a very thin line of matter as a hair could be made up of a number of distinct parts running through its entire length. But so it is proved by the microscope. This diagram shows a magnified view of the different parts. It shows that around the central part or core of the hair, there are four different layers of structure.

This figure (vertical section running through finger end) shows the growth of a nail from the outer skin. Both the hair and the nails are skin-growths. That is, at certain places of the bo y, the skin grows into these peculiar forms for special protection *to organs and other useful purposes.*

Structure of Muscle.—When we studied the muscles of the body we learned that they are like strong ropes attached at each end to some part of the body—generally a bone—to give motion to the limbs and organs, by strongly shortening up or contracting. This fine microscopic figure gives us a clear view how these (Chart) delicate little chains of muscle cells are first spun together, as it were, into muscle cords, and how these cords are again bound together into such a strong rope or cable to give it immense strength and power of motion.

EXERCISE XXVI.

Structure of the Skin.—The skin besides serving as a general covering for the body, is a wonderfully delicate and complicated organ. This illustration (Chart) will help us to understand this fact. Looking at the edge of a piece of skin with the microscope, we have what is shown before us. Let us study its separate parts. Here (A) is the outer or scarf skin, called the *epidermis.* Having no nerves in it, it feels no pain. It is the part which is raised by a blister. It serves as a protection to the true skin immediately beneath it.

Where such protection is most needed, the scarf-skin is thicker than at other places, as in the hand or on the sole of the foot. By much use it becomes thicker and harder.

"The boy who goes out barefooted for the first time, 'treading as on eggs,' can soon run where he pleases among thistles and stones. The blacksmith handles hot iron without pain, while the mason handles the roughest stones without scratching his flesh." Now comes the color layer (B) which in the Negro is black, in the Indian brown, and in your bodies white. Next (C) are shown the delicate capillary blood-vessel loops. Then we have (D) nerve loops to receive the impression of touch and pain. Here (E) are the sweat-glands with their tubes leading out upon the surface to discharge the perspiration as at (F). These glands (G) produce from the blood an oily substance which is carried to the surface (H) to keep the outer skin smooth and soft. Here (I) are shown some of the muscles which move the skin. Here (L) are two representations of the sacs from which the hair grows. These (U) are cells of fat layers in the skin. Finally, these red and blue vessels are arteries and veins carrying blood to and from the skin.

EXERCISE XXVII.

Coats the Stomach.—The stomach has three coats. This figure (Chart) shows us at (A—1, 2, 3) the inner coat. Notice first (1) this lining of cells whose work it is to produce and throw upon the food in the stomach a fluid called the gastric juice, which has a very important part to perform in fitting the food for body material. Back of these cells (2) lies a thin layer of muscle. Then (3) another thin layer of soft tissue dividing the muscles of the inner coat from the second or muscular coat. This (B) muscular coat has its muscle strands running in two chief directions (4, 5). The object of this is to move the stomach more or less in different directions so as to produce a sort of mixing or churning effect on the gastric juice and food within, thus making the digestive process more complete. Lastly, we have at (C) the outer protective wall of the stomach, which is a continuation of the lining coat of the abdomen.

View of Intestines.—The three coats of the intestines are similar to the corresponding coats of stomach. Notice, however, that instead of the gastric cells found in the inner coat of the stomach we have here (1) what are called *vilei.* These are peculiar little mounds of cells whose appointed work it is tc carry the nutritious part of the food (chyle) from the intestines to the lacteal tubes (7) which, in turn, carry it forward into vessels of the circulatory system. Notice, also how these blood-vessels—capillaries (2), arteries (8) and veins (9) penetrate these walls of the intestine. The first and second coats (C B) are entirely similar to the first and second coats of the stomach. Besides showing us these coats of the intestine, this diagram shows us also here at (D) the chyme—which is the food after it has passed through stomach digestion—flowing from the stomach into the intestine.

TO THE TEACHER.

The following exercises are intended to furnish you such suggestions as will help you in the use of the three excellent plates of the Study designed to illustrate the terrible effects of strong drink on the human body. If your work in teaching the preceding lessons in elementary Physiology has been well done, you will find it both easy and delightful to "show up" the "Monster Vice," not after the manner of "cheap temperance talk," but in such an intelligent, practical and convincing way, that your pupils, will, by education, be fortified against the danger and destruction of drink. While you are engaged in such work, you are handling the very strongest temperance weapon, and the extent of good you may do, by saving from ruin the lives and future homes of your pupils, cannot be told in advance. Let this encourage you to do this work conscientiously and well. Do not be satisfied with a hasty showing of serious effects of intemperance by a brief exhibition before your pupils of the figures on these plates. They do, indeed, "on the face of them," tell a sad story. But they are intended to do more. They are to help you expose the nature of the cause, of which the condition they represent is the inevitable consequence.

In approaching this subject it will be well for you to spend the time of one lesson in a preparatory talk on intemperance. This will arouse the pupils' interest in advance, which is always a great point gained. Let this talk be very familiar. Let it abound in questions drawing on the pupils' observation and knowledge. There is scarcely a school district in the country which does not furnish practical object lessons on this subject. Be careful to wound no one by personal allusions. Do not aim at intemperate habits the arrow of ridicule. Let all your work as a teacher of temperance truths be animated by the spirit of benevolence and reform. By all means let your pupils, after this preparatory talk, carry home with them an impression of the sad fact that strong drink is by far the greatest and most ruthless destroyer of health and life among the human family.

In conclusion, show them, briefly, the three temperance plates, and tell them that you are going to use them in future lessons to illustrate the serious consequences of the drinking habit; that the subject of the next exercise will be: "What is strong drink?" And that you wish them to be prepared to tell you all they can about it.

EFFECTS OF

ALCOHOLIC STIMULANTS.

EXERCISE XXVIII.

Let us try to learn what is meant by strong drink. How many can mention some kind of strong drink? (Hands up.) (Draw from this and that pupil: beer, wine, whisky, ale, porter, brandy, etc.) Why do we call these strong drinks? Harry—Because they taste strong. Fred—Because they make men drunk.

You are both right. They taste strong and they make men drunk. But let us learn what it is that makes them all taste strong, and why it is that they make men drunk.

Of what is wine made? (From the juice of grapes) Yes, there are many different kinds of wine made from grape-juice. But we also speak of wines made from other fruits. Can you mention any such wine? (Currant wine, gooseberry wine, cherry wine, etc. Apple wine is called cider.) Now, all these fruits from which these wines are made contain sugar, which, when they are well ripe, can be tasted. This sugar is dissolved in the juices of the fruits. When any of these juices is allowed to stand in warm air, the sugar in it is changed into two kinds of substances. One of these new substances, into which the sugar is changed, passes off in gas bubbles, and in so doing makes the liquid froth. The other substance remains in juice, which now tastes strong, instead of sweet. The juice is now called wine, and the new substance in it, which has taken the place of the sugar and made it strong, is called alcohol. In this way all wines are made and all contain alcohol. Now, let us learn about beer. In sprouting grains, such as barley, rye., etc., there is also contained some sugar. So the brewer causes large qantities of grain to sprout, then extracts its juices and sugar, and by various processes brings about the same change in this grain sugar which we learned was produced in the fruit sugar. The gas substance, when allowed to escape, makes the liquid foam. The alcohol remains in it to make it strong. To this hops and hotter substances are made to add a flavor, and the mixture is called beer, ale, or porter, as the flavor may be. In this way the beers are made, and all contain alcohol.

How about gin, whisky, rum and brandy? These are made in a similar way, but contain larger proportions of alcohol. (Explain "proportion" or "per cent." to your pupils.) They are stronger drinks than the wines and beer, and often are grouped separately as liquor or spirits. They rank in strength about as follows: gin is about one-third alcohol; whisky about 45 per cent.; rum 48 per cent. and brandy 50 per cent.

In all these strong drinks, wines, beers and spirits, it is the alcohol that is in them which makes them strong. In our future lessons we shall see how it makes men drunk.

EXERCISE XXIX.

It is suggested that the teacher, as a preparation for this exercise, procure a vial full of alcohol for the purpose of illustrating to his school, by a few simple experiments, some of the properties of this substance. The interest which this will create, to say nothing of the instruction it will afford, will be worth many times the small sum of money it will cost at the nearest drug store.

Assuming that this has been done, the lesson proceeds as follows:

What strong substance have we found to be contained in all strong drinks? (Alcohol.) Alcohol, in its ordinary form, when separated from other substances, is a liquid as clear as water; How many of you would like to see some of it? (Hands up.) I have brought some with me to show you. (Let them have a good look at it.)

One of the properties of this harmful substance is that it is very inflammable. Let me show you. (Pour a small quantity into a sauce dish and carefully light a match.)

Another important property of alcohol is its greed for water. It will take away water from any substance containing it. A piece of flesh placed in alcohol soon becomes shriveled and hard. The white of an egg is called albumen. This substance is found in many parts of the body. I will try to show you how alcohol robs it of its water and changes it. (Place in a goblet the white of an egg. Cover it with alcohol. In a few minutes the albumen has changed to a white, hard condition.) Is it a wonder that such a substance produces harm when it is repeatedly made to pass through the delicate organs of the body? I am now going to explain to you the first of the four stages or grades of effects produced when strong drink is taken into the body. After taking a glass of strong drink, it passes directly to what organ ? (To the stomach.) Now, the food generally stays in the stomach until it has been much changed by that organ. When it has been properly changed we find that it goes where ? (Into the intestines.) Right. But there are some liquid substances which, instead of remaining in the stomach to be changed and then pass into the intestines, pass, as it were, through the walls of the stomach into the veins. This is especially true of alcohol. It is quickly taken into the veins from the stomach. Now, to what system do the veins belong? (To the circulatory system.) So we have the alcohol now in the circulation, and, of course, floating on with what? (With the blood.)

The large blood-vessels branch off into smaller ones, and these again into very small hair-like tubes. These small blood-vessels are very numerous near the surface of the body. When the alcohol gets into these, it weakens their work so they lose their firmness and the blood swells them out, and, of course, runs through them much faster.

The face gets red, and the whole surface of the body becomes flushed, because the blood is crowding through these small blood-vessels and swelling them out. Now, how many of you understand how the face becomes red after drinking strong drink? (Hands up.)

Now, this warm, excited blood crowding through these small blood-vessels produces a great heat. So the surface of the body becomes warm. But do not get the idea which has deceived so many, that alcohol produces heat in the body. It simply gathers heat from the body near to the surface.

By the disturbance which alcohol has made in the circulatory system, the heart becomes excited. It jumps, flutters, and beating faster and faster, it sends the blood hurrying through all its channels. The brain now gets crowded with blood, and it becomes excited. To what system does the brain belong? (To the nervous system.) So you see the trouble has reached the nervous system. Through the excited brain the mind acts quicker, the person is apt to talk more, and laugh more, and feel altogether "jolly." His circulation, his nerves and his mind are all whipped up like spurred horses.

Now, what have we learned? How does the drinker look after his first drink? (Red-faced, flushed.) How does he feel? (Warm and "jolly.") How does he act? (Excited, lively, or even "silly.") From the action of alcohol in this first stage it has been called a stimulant. This first stage we will call the state of excitement.

EXERCISE XXX.

What did we call the first stage of effects of alcohol? [The stage of excitement.] Why may it be called the stage of excitement? [Because the first effects of strong drink is to excite the circulation, the brain and the mind.] Now, I wish all to understand that this first stage is the snare which draws men into the habit of drinking again and again. For the sake of this short sensation of warmth and lively feeling, forgetting all consequences, the person takes the second drink, and the third, and so on. But let us learn what follows this first stage of excitement.

After a little while the effects of alcohol on the little blood-vessels weakens, the heart settles down from its excitement, and the flush of the face and skin dies away. The heat which had been carried to the surface of the body is given to the air and surrounding objects. Now, since the alcohol does not furnish any heat to the body, what must follow this loss of the surface heat? [A chilly condition of the body.] Right; and the heart, weakened by its flutters, instead of crowding the brain with blood, now scarcely sends it a sufficient quantity; so a dull, drowsy condition of the mind takes the place of the former jolly feeling.

So we have in this second stage, instead of a feeling of warmth, what? [A feeling of chilliness.] Instead of the former cheeriness? Drowsiness. All the organs of the body which had been spurred up to unnatural activity are now in a jaded and depressed condition. So we will call this second condition the stage of "depression."

Thoroughly test your pupils on the points of this important exercise.

EXERCISE XXXI.

A man who has partaken of strong drink may pass through the bodily excitement which it produces and recover from the depression which follows without really being drunk. People would say that he is "under the influence of liquor." But suppose he repeats the doses of drink until he is drunk. Here we have a third stage of effects which we will now study.

How many of you have seen men who were said to be drunk? What have you noticed in their manner and movements? (Draw out: stammering and awkwardness of speech; squinting look of the eyes and staggering walk.) Now, let us draw on our knowledge of Physiology for an explanation of these things. What part of the nervous system passes down from the brain through the back? [The Spinal cord.] What branches out from this spinal cord all along its length. [Nerves.] Where do these nerves go? [To different parts of the body.] For what purpose? [To control the actions of the muscles, and to receive impressions of touch or feeling.] Very well. Now, after a large dose of drink, not only the brain, but this spinal cord also becomes much disturbed. One after another the nerves which branch out from it lose their control over the muscles to which they go. The first to fail are the nerves which go to the lower lips and tongue. What do you suppose is the consequence of this? [A stammering sort of speech.] Correct. Next the nerves which go to some of the muscles of the lower limbs fail to control them, and what is the result? [A staggering walk.] By and by the nerves fail to control the muscles of the eye. What follows now? [Squinting and rolling the eye.] Now, how many see how alcohol makes a drunken man stammer and stagger and squint? (Hands up.) But this is not all. In this dreadful third stage the brain is entirely confused. The mind is deranged. The better thoughts and nature of a man are suppressed. He is controlled by his lowest and worst passions. So men in this stage are seen in their most ridiculous tempers. "The coward shows himself more cowardly, the braggart more boastful, the bold man more daring, and the cruel more brutal." The poor victim is so weak that a child could topple him over, and so childish that any one can impose upon him.

Here let us leave him until our next lesson.

EXERCISE XXXII.

Review conditions and causes of the drunken stage. In what condition did we leave the victim of drink at the close of our last lesson? [Drunk.] True; that is a short, but very expressive way of naming the poor man's condition. But let us recall what that dread word means. What is the condition of the organs of a drunken man? [They are diseased and distressed.] His speech? [Stammering.] His walk? [Staggering.] His eyes? [Squinting and rolling.] His mind? [Deranged.] His conduct? [Ridiculous and mean.]

There is still another or fourth stage, of which I will now tell you. It is the very next door to death. When a person gets to this stage, people say he is "dead drunk." What does this mean? From the terrible strain of the third stage, the strength of every organ yields at last and general prostration follows. The man now falls into the deep sleep, for he can neither hear nor see nor feel. His limbs drop down helpless when you raise them. Why? Because the nervous system has very nearly suspended its work. Suppose it had entirely suspended, what would be the man's condition? [Dead.] Yes, but fortunately there is one part of the nervous system which holds out when all the rest have given up. This is the part which governs the action of the breath. Now, how much of life is there left in the man? [His breath.] Let this part of his nervous system also yield to the shock, what then? He is dead! but generally the flickering life-lamp recovers its burning. Does he take warning from his terrible experience? No; he will repeat it again and again, until he is conquered by his enemy.

Such, my pupils, are the effects of alcohol on its victims. But while all these conditions of which we have learned exist during the continued indulgence of the passion for strong drink, there is a destruction going on in the suffering organs of the body which of itself hastens the death of the man who drinks. And now in our next lessons I am going to use the figures on the Study to illustrate to you still farther alcohol's terrible work of destruction.

EXERCISE XXXIII.

INTEMPERANCE PLATES.

What organ does this represent? [The stomach.] In what condition? [In a healthy condition.] Now, I wish you to notice well its appearance. Of course this represents it as laid open, so that what we see is its inner wall. It has, as you see, a uniform, rosy tint. Though its inner coat is so well supplied with delicate little blood-vessels as to give it a rosy appearance, not one of these little blood-vessels can be seen when we look at the lining of a healthy stomach, Now, in studying the effects of alcohol, what was about the first trouble we find it to produce? [It weakens and crowds the small blood-vessels.] Yes; wherever it goes in the body it has that effect. Now, you can see clearly that the little blood-vessels of the stomach are first and most exposed to its effects. This second figure shows us how a few glasses of strong drink will bring out to the surface of the stomach's lining these crowded and swollen blood-vessels. Of course, this is a diseased condition. No such stomach can properly perform its part in digestion. But let us pass to the next figure.

Here we have a representation of parts of several other organs besides the stomach. What is this? [A part of the intestines.] Here is the pancreas and here is the spleen. This shows nicely how the tubes from the liver and pancreas open into the upper intestines. This represents the condition of these parts after what would be called "a long drunken spree."

What do you notice here besides the swollen blood-vessels? [Large, bluish patches.] These show that in this stomach-wall there is a thickening of impure blood, or what the doctors call stagnation of blood—a very dangerous condition. (Turn to next plate.) As the habit of drink continues, the strongly-inflamed lining of the stomach breaks out in ugly ulcers, as shown in this figure. We can hardly imagine how much pain the unhappy possessor of a stomach so badly diseased must endure. These next figures show us that inflammation and ulceration go on in the intestines as well as in the stomach. Give your pupils some idea of the terrible condition of *delirium tremens*, or trembling madness. The last figure on the plate speaks for itself. Remind the pupils that the stomach here shown passed from the healthy condition of the first figure through the inflammation of the second and third, the ulceration of the fourth, to the fatal mortification here represented.

Next exercise we will learn of the effects of strong drink on some other organs of the body.

EXERCISE XXXIV.

KIDNEY, BRAIN AND LIVER PLATE.

The first figure on this plate shows a diseased condition of the kidney. This organ is represented as laid open in halves. This condition, as you see, is called "fatty degeneration." The use of beer is very likely to produce this trouble. You notice the large gathering of fat both inside and outside of the organ. Nothing of the kind appears in the healthy state of the kidney. You are hardly prepared to understand how alcohol produces a growth of fat in the body. But it has this effect, not only on special organs like the kidneys and the heart, but you have possibly yourselves noticed that beer drinkers are often thickest in body. Some people think they are fleshy, but really they are fatty. They often have less muscle or real flesh than many slender people have, and generally their limbs are weak and flabby. This is really a diseased condition of the body; yet, strange to say, some ignorant people mistake it for health, and credit it to the use of strong drink.

The next figure shows how alcohol may affect the brain. See how this brain part is shrunken. How many remember the experiment with alcohol on the white of an egg? (Hands up.) What was the effect? (The albumen or white of the egg was quickly hardened and shrunken.) What property of alcohol did we learn produces such effects? (Its greed for water.) In the brain there is much albumen and water. When much exposed to the action of alcohol it hardens and shrinks. Skillful physicians say they could tell the brain of a drunkard by touching it in the dark. Now, we have one more figure to examine. It shows a very bad condition of the drunkard's liver. It is said that when the organs of the body are distressed by alcohol, the self-sacrificing liver tries to save the rest of the body by taking in itself much of the poison like a sponge takes in water. The consequence is that it soon becomes a suffering organ. One of the worst conditions of alcoholic liver disease is here represented. The whole organ, and especially the left part is very much shrunken. Its surface is covered with projections like nail-heads. It is called a "hob-nailed" liver, from its resemblance to the shoe-sole of an English cartman.

That diseased organs like these we have been studying quickly bring on death, is certainly no wonder. All these figures are exact pictures of real diseased organs taken from the dead bodies of victims of strong drink, who died in hospitals of Chicago.

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APPENDIX.

SUPPLEMENTARY LESSONS ON THE ANATOMY OF THE EXTREMITIES AND THE PRACTICAL USE OF THE SKIN PLATE.

STRUCTURE OF THE ARMS AND LEGS.

(Refer to manikins of these parts.)

In these beautiful views of the structure of the extremities we find the distribution of bones, muscles, nerves and blood-vessels. So four great systems of the body—the bony, the muscular, the nervous and the circulatory systems—are here represented. If we learn from these sections how these organs are distributed in these parts, we shall have quite a fair idea of their distribution throughout the whole body. So let us examine the

First Arm Section.—The skin is supposed to be removed. The most prominent organs which we observe here are the *veins*—blood-vessels of the circulatory system. We have learned before, that the blood is carried *to* the heart by veins, and *from* the heart by arteries. In that division of the circulation which sends the blood from the left side of the heart to all parts of the body, to be collected again and returned into the right side of the heart, the arteries carry the *pure*, and the veins the *impure* blood. The current of the blood in the arteries is very strong on account of the powerful action of the heart. Consequently, the rupture or cutting of an artery is a serious matter. Hence, as we shall see, the arteries, as a rule, lie deep, and are thus rather removed from danger. This is a wise provision. In the veins, on the contrary, the blood flows along languidly. So there is far less danger on account of loss of blood from cutting a vein. These vessels may, therefore, safely lie nearer the surface. And so we find it to be. Here (III, IV, V, *on fore-arm*), we see three great veins—the *cephalic* (III), so called because it runs up towards the head (not *to* the head), the *median* (IV) or "middle," and the *basilic* (V) or "royal" vein. These, we notice, gather the blood from many smaller veins in the fingers, hand, wrist and fore-arm. In the upper-arm we see how the chief veins of this limb increase in size—just as a river widens and deepens from inflowing creeks and rivulets—and how they dodge under and between the muscular bundles. The veins at (I), near the shoulder, are called *sub-cutaneous*, because they lie very close to the skin.

Second Arm Section.—Besides showing us, again, the great veins of the arm, the *brachial* or great arm artery (A), and the *radial* artery (B) are shown. But this section brings the muscular structure of the arm specially before us. Here (20) is the great *biceps* muscle which raises the fore-arm. At (23, *upper-arm*) is the *triceps*, which acts counter to the biceps, in straightening the arm. On the fore-arm we see the muscles which go to the wrist, hand and fingers, to perform the most skillful muscular work of the whole body. Near the shoulder (20, 20′), above the wrist (22), and in the hand (24), the tendon extensions and attachments of the muscles are shown. At the shoulder (8, 9),we see the strong ligaments which bind together the collar and shoulder bones. Here, at the wrist (12), is the curious ligamentary bracelet which so neatly holds down, quite close to the bone, all the muscles, nerves and blood-vessels which pass to and from the hand.

Third Arm Section.—Here, besides prominent muscles, great nerve lines are brought to view. The bones also begin to appear. The nerve (h) sends its branches to the skin. The nerve (f) is the *median* or great "middle nerve" of the arm. The *ulnar* nerve (g) and the *radial* nerve (l) are named from the arm bones of corresponding names, along which they run.

Fourth Arm Section.—This leads us down deeper into the anatomy of this limb. The most prominent features before us now are the arterial channels of the arm. The *axillary*, or "arm-pit" artery (A), becomes the *brachial* or "arm" artery at (B). This, in the fore-arm, divides into the *radial* artery (B) and the *ulnar* artery (G). From these great trunk lines, numerous branches go out to supply pure blood to every part of this extremity. The great upper-arm bone—the *humerus*—now clearly appears.

Fifth Arm Section.—This section shows us more fully how the arteries of the arm branch out—especially their distribution to the hand and fingers. At (31) and (38) are two *pronator* muscles. The first is called the round pronator and the second the square pronator, from their comparative shapes, as muscular bundles. They roll the arm so as to turn the palm of the hand downward. Here, (*above* 19′), the great *deltoid* muscle which moves the arm directly upward is shown as cut off. The fore-arm bones now appear—(4) showing the *ulna*, and (6) the *radius*.

Sixth Arm Section.—Here, beside the bony skeleton or framework of the arm, we have a fine view of the strong cords and bands of ligaments which firmly bind the bones to each other. All other structures surrounding the bony shaft of the arm, are here removed, to show the numerous nerve lines which send their countless branches to all the muscular fibres and to all points on the surface—the former to direct the various movements of hand and arm, and the latter to receive impressions to be conveyed to the nervous centers.

First Leg Section.—As we might suppose, the general structure of the lower extremities is very similar to that of the upper extremities. So this first section of the leg—like the corresponding section of the arm—shows prominently the veins which gather up the impure blood to carry it upward to the heart. Some of these veins lie very close to the surface, under the skin, and for this reason, as in the arm, are called *sub-cutaneous* veins, which means veins under the skin. Others are more deeply located among the fleshy tissue of the leg. We notice also quite a number of branches of arteries which come to the surface to supply the skin and the outer layers of muscles with blood.

Second Leg Section.—The great muscles which have so much to do with the common act of walking, as well as with the strongest physical acts of the body, are here made prominent. This important muscle (9, *upper-leg*) is called the *sartorius* muscle. This means the "tailor muscle"—so called because its use is to cross the legs, while at the same time, it is about as long as the tailor's yard-stick, making it the longest muscle in the whole body. The work of this great *rectus* or straight muscle (10) is to straighten the limb. At the knee, (1) shows the "knee-cap" or *patella* bone. In the lower leg, (1) shows the *tibia* bone. Farther down, (7), we notice a ligamentary anklet, which serves a purpose similar to that of the ligamentary bracelet of the fore-arm or wrist.

Third Leg Section.—The great *femoral* artery (A) is here shown as carrying quite a stream of pure blood into the leg, to be distributed by numerous smaller arterial branches to all parts of this extremity. This great vein (I) is the *saphenous* or "manifest vein." The nerves which appear on this section, are chiefly those which go to the skin and the outer muscles.

Fourth Leg Section.—Now the *femur*—the largest and strongest bone of the body—comes to view. Notice, at the knee, its strong ligamentary union with the tibia bone of the lower leg. (3) shows the *fibula*—the thin slender bone which lies beside the tibia. The five *metatarsal* or "middle-foot bones" are shown at the figures (6) The toe joints of bone—that is, the *phalanges*, appear at (7, 8).

Fifth Leg Section.—More of the arterial branches are shown on this section. Between the two bones of the lower leg (10) we see a membranous substance which extends from bone to bone. The lower leg artery (A) is called the *anterior tibial* because it passes down *in front* of the tibial bone. It is also thus distinguished from the *posterior tibial* artery which passes down *behind* the tibial bone.

Sixth Leg Plate.—Here, as in the corresponding section of the arm, we have, first, the bony skeleton or frame-work of the leg. Then, all other parts being removed, the distribution of the great nerve lines to all parts of the leg is shown.

PRACTICAL USE OF THE SKIN PLATE.

By the use of the transparent skin plate, very important practical lessons may be learned in regard to the location of the great vital organs of the body which lie within, with reference to the surface of the body. A great deal of ignorance, on this subject, exists, even among grown people. The author recalls an occurrence in his experience, when, while standing up with others to be initiated into a certain order, the man who stood next to him, on being directed to place his right hand over his heart, placed it squarely across his stomach.

Turning aside the plate which shows the outer muscles of the trunk, and bringing the skin plate over the remaining sections, we may, among other observations, learn the following facts: The lower border of the stomach is very nearly on the line of the narrowest front width of the body, immediately below the chest. The navel or umbilicus, on the surface, lies very nearly centrally over the intestinal region within. The large intestines, within, come quite down to the furrow line between the skin of the abdomen and the skin of the thigh. The location of each rib may be easily felt on one's own body.

Turning aside the rib section and bringing over the skin, again, we see that the lungs lie on either side of the middle line passing down through the chest; that their upper apexes come nearly up to the line which joins the outer angles of the shoulders, and that their lower apexes extend to about within an inch of the narrowest front width-line of the body.

The outer lung section being removed, we find that the heart lies chiefly on the left side of the median chest line, its center nearly on the middle cross-line of the chest. Turning aside the liver, and again bringing the skin plate over, we notice that under the navel, the great descending aorta forks, to send a great branch to each of the lower limbs. Directly under the lower edge of the stomach, which we have found to be on the narrowest width-line of the body, the aorta sends out right and left arteries to the corresponding kidneys.

Besides these observations, the course of a bullet, fired directly into the front body, can be quite reliably studied by marking the point of its entrance on the skin plate and then tracing the line from such point through the organs within. It is plain that many such lines would pass through vessels and parts making the wound absolutely fatal, while others would not strike any vital part whatever.

INDEX TO SECTIONS OF EXTREMITIES.

UPPER EXTREMITY.

SECTION I.

Arm—(1) Acromion process. (12) Fascia of pectoralis muscle. (13) Deep fascia of arm. (18) Deltoid muscle covered with fascia. (19) Pectoralis major muscle. No arteries except small muscular (B) or cutaneous branches are shown. (I) Subcutaneous veins. (II) Basilic vein. (III) Cephalic vein. (IV) Median and median cephalic veins. (a) Supraclavicular nerve. (b) Posterior cutaneous, from the circumflex. (c) Branches from the anterior thoracic. (d) Internal cutaneous. (e) Lesser internal cutaneous. (h) Musculocutaneous.

Fore-arm and Hand—(9) Deep fascia. (10) Bicipital fascia. (11) Palmar fascia. (11') Transverse palmar ligament. (12) Anterior annular ligament. (14) Paniculus adiposus of the fingers. (29) Palmaris Brevis muscle. (III) Cephalic or radial vein. (IV) Median vein. (V) Median Basilic vein. (a) Branches of internal cutaneous nerve. (b) Same. (c) Branches of musculo-cutaneous nerve. (i) Palmar branch of the ulnar nerve. (m) External cutaneous branch from musculo-spinal nerve.

SECTION II.

Arm—(1) Acromial end of clavicle. (2) Coracoid process of scapula. (3) Greater tuberosity of head of humerus. (4) Lesser. (5) Bicipital groove. (8) Coraco-clavicular ligament. (9) Coraco-acromial ligament. (10) Capsular ligament. (15) Bicipital fascia. (16) Pectoralis major tendon. (17) Triceps muscle. (19) Pectoralis major. (20) Biceps. (20') Short head of biceps. (20") Long head of biceps. (21) Coraco-brachialis muscle. (22) Brachialis anticus muscle. (23) Triceps muscle. (A) Brachial artery. (D) Inferior profunda. (III) Cephalic vein. (IV) Median

Cephalic. (V) Venae comites—brachial. (VI) Beginning of Cephalic.

Fore-arm and Hand—(1) Internal condyle of humerus. (9) Deep fascia. (10) Aponeurosis of biceps muscle. (11) Palmar fascia. (12) Anterior annular ligament. (13) Sheaths of flexor tendons—circular and oblique fibers. (15) Biceps muscle. (15) Inferior bicipital tendon. (16) Brachialis anticus muscle. (17) Triceps. (18) Supinator longus. (22) Flexor carpi radialis. (23) Palmaris longus. (24) Flexor sublimis digitorum. (27) Flexor carpi ulnaris. (28) Pronator quadratus. (29) Palmaris brevis. (30) Abductor pollicis. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (36) Lumbricales. (B) Radial artery. (G) Ulnar artery, forming the superficial palmar arch. (K) Digital branches. (N) Superficial radial nerve. (N") Dorsal branch.

SECTION III.

Arm—(1) Acromio-clavicular joint. (2) Coracoid process. (3) Greater tuberosity of head of humerus. (4) Lesser. (11) Sheath of biceps tendon. (16) Insertion of pectoralis major muscle. (17) Insertion of deltoid. (18) Deltoid. (20') Long head of biceps. (20") Short head. (21) Coraco-brachialis. (22) Brachialis anticus. (23) Triceps. (A) Brachial artery. (B) Muscular branches. (C) Superior profunda. (D) Inferior profunda. (d) Internal cutaneous nerve. (f) Median nerve. (g) Ulnar. (h) Musculo-cutaneous.

Fore-arm and Hand—(1) Internal condyle. (2) Radius. (3) Ulna. (4) Pisiform bone. (5) Unciform bone. (6) First phalanges. (7) Second. (8) Third phalanges. (15) Biceps tendon. (16) Brachialis anticus. (19) Extensor carpi radialis brevior. (20) Supinator brevis. (24) Flexor sublimis digitorum. (26) Flexor longus pollicis. (28) Pronator quadratus. (31) Opponens pollicis. (32) Flexor brevis pollicis. (33) Adductor pollicis. (34) Abductor minimi digiti. (35) Flexor brevis minimi digiti. (37) Interossei. (A) Brachial artery. (B) Radial. (C) Superficial volar branch. (D) Dorsal branch. (E) Ulnar artery. (F) Interosseous. (G) Superficial branch for superficial palmar arch. (K) Digital branches. (V) Venae comites. (d) Median nerve. (d') Muscular branch. (e) Internal interosseous. (g) Digital branches. (k) Ulnar nerve. (k, k') Digital and muscular branches. (l) Radial nerve. (n) Superficial radial. (n') Anterior. (n") Posterior branches.

SECTION IV.

Arm—(2) Acromion process. (2') Coracoid process. (3) Clavicle. (4) Greater tuberosity. (11) Capsular ligament. (12) Sheath of biceps tendon. (20) Long head of biceps. (24) Internal head of triceps muscle. (24") External head of triceps. (24"') Middle or scapular head of triceps. (A) Axillary artery. (B) Brachial artery. (C') Acromial branch of transverse scapular artery. (D) Thoracic branch of brachial artery. (E) Acromial thoracic. (F) Long thoracic branch. (G, G') Subscapular artery and branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda.

Fore-arm and Hand—(16) Anterior ligament, elbow joint. (18) External lateral ligament. (18') Part of orbicular ligament. (20) Interosseous ligament. (5) Styloid process of ulna. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Trapezium. (11) Carpo-metacarpal joint of thumb. (12) Metacarpal. (13) First phalanges. (14) Second phalanges. (15) Third phalanges. (16, 18, 18') Ligaments of elbow joint. (31) Pronator radii teres. (32) Supinator brevis muscle. (33) Flexor carpi radialis. (34) Pulmonis longus. (35) Flexor sublimis digitorum. (36) Flexor profundis digitorum. (37) Flexor longus pollicis. (38) Pronator quadratus. (39) Adductor pollicis. (40) Abductor minimi digiti. (41) Palmar interosseous. (B) Radial artery. (D) Dorsalis pollicis. (G) Ulnar. (G') Ulnar recurrent. (H) Interosseous. (I) Metacarpal branch. (K) Termination of ulnar which is continued as the superficial palmar arch.

SECTION V.

Arm—(2) Acromion. (3) Clavicle. (22) Coracoid process. (4) Greater tuberosity of head of humerus. (12) Sheath of biceps tendon. (19) Insertion of pectoralis major. (20) Biceps tendon, long head. (21) Short head. (22) Coracobrachialis. (23) Brachialis anticus. (24) Triceps muscle. (A) Axillary artery. (B) Brachial. (F) Long thoracic. (G, G) Subscapular and its branches. (H) Anterior circumflex. (I) Posterior circumflex. (K) Muscular branches. (L) Superior profunda. (M) Inferior profunda. (F) Anastomotica magna.

Fore-arm and Hand—(2) External condyle of humerus.

(4) Ulna. (6) Radius. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform. (10) Trapezium. (11) Trapezoid. (12) Metacarpal. (13, 14) Phalanges of thumb. (16) Anterior ligaments. (20) Interosseous ligaments of elbow joint. (22, 23, 24) Ligaments of wrist joint. (30) Tendon of biceps—insertion. (31) Pronator radii teres. (32) Supinator brevis. (36') Tendons of flexor sublimis digitorum. (38) Pronator quadratus. (41) Interosseous. (A) Brachial artery, lower end. (B) Radial artery. (C) Superficialis volæ. (D) Dorsal branch of radial. (D', D'') Dorsal branches to thumb. (E) First digital branch. (E', E'') Branches to ulnar and radial sides of thumb (princeps pollicis). (F) Deep palmar branch. (G) Ulnar artery. (G') Ulnar recurrent interosseous. (H') Anterior interosseous. (I) Dorsal branch. (K) Ulnar dividing into deep and superficial branches; the superficial joining (C) to form (K), the superficial palmar arch—the deep branch joining from the radial to form (L'), the deep palmar arch. (M) Digital branch to little finger. (N) Common digital branches. (O) Interosseous arteries. (P) Digital.

SECTION VI.

Arm—(2) Coracoid process. (3) Clavicle. (4) Greater tuberosity of humerus. (9) Coraco-clavicular ligament. (10) Coraco-acromial. (11) Capsular ligament. (12) Sheath of biceps tendon. (16) Anterior ligament of elbow joint. (17, 18) Lateral ligaments. (20) Long tendon of biceps. (18') Orbicular ligament. (A) Position of axillary artery. (d') Long thoracic. (e) Anterior thoracic. (f) Subscapular. (g) Internal cutaneous of arm. (g') Posterior branch. (h) Middle cutaneous. (h') Ulnar cutaneous branch. (i) Musculo cutaneous nerve. (k) Circumflex. (l) Posterior cutaneous of arm. (m) Median nerve. (n) Ulnar nerve. (o) Muscular spiral. (o') External cutaneous branch.

Fore-arm and Hand—(1) Internal condyle of humerus. (2) External. (3) Internal part of trochlear surface of humerus. (4) Ulna. (5) Styloid process. (6) Radius. (6') Neck of radius. (6'') Bicipital tuberosity. (7) Styloid process of radius. (8) Pisiform bone. (9) Unciform bone. (10) Scaphoid. (11) Trapezium. (12) Metacarpus. (13, 14, 15) Phalanges. (19) Oblique ligament. (20) Interosseous membrane. (21, 24) Straight and oblique volar ligaments. (22, 23) Lateral ligaments. (25, 26) Anterior carpal ligaments. (27, 28, 29, 30) Carpal, metacarpal and transverse ligaments. (a) Lesser internal cutaneous nerve. (b') Palmar branch. (b") Ulnar cutaneous branches. (c) Musculo-cutaneous. (d) Median nerve. (d') Muscular branches. (e) Interosseous branch. (f) Long palmar. (g) Digital branches. (h) Ulnar nerve. (i) Dorsal branch. (k) Palmar branch. (k') Superficial palmar branch. (k") Digital branches. (k'") Deep ulnar branch. (l) Radial. (l') External cutaneous branch. (m) Posterior branch. (n) Anterior. (n') Dorsal branch of thumb.

LOWER EXTREMITY.

SECTION I.

Thigh—(1) Patella. (5) Fascia lata. (6) Crural fascia. (8) Bursa patellae. (I) Internal saphenous vein. (II) Subcutaneous veins. (a) External cutaneous nerve. (b) Branch of genito-crural nerve. (c) Branch of inguinal. (e) Internal cutaneous nerve. (f) Middle cutaneous.

Leg—(2) Internal malleolus. (4) External malleolus. (6) Deep fascia of the leg. (7) Anterior annular ligament. (8) Dorsal fascia of the foot. (I) Subcutaneous veins. (II) Long saphenous vein. (a) Long saphenous nerve. (b) Musculo-cutaneous. (c) Cutaneous branches of external popliteal. (d) Internal cutaneous of the dorsum of foot. (e) Middle cutaneous of dorsum. (g) Digital nerves.

SECTION II.

Thigh—(1) Patella. (2) Internal condyle of femur. (3) Of tibia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (14) Pectineus muscle. (15) Adductor longus. (17) Gracilis. (I) Long saphenous vein. (II) Subcutaneous veins. (e) Branches of internal cutaneous nerve.

Leg—(1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Metatarsal. (7) Anterior annular ligament. (9) Tibialis anticus. (10) Extensor digitorum longus. (10') Peroneus tertius. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (A) Anterior tibial artery. (A') Dorsalis pedis artery. (III) Deep veins of leg.

SECTION III.

Thigh—(1) Patella. (2) Internal condyle of femur. (3)

Of tibia. (5) Deep fascia. (9) Sartorius muscle. (10) Rectus muscle. (11) Vastus internus. (12) Vastus externus. (13) Psoas and internal iliac muscles. (14) Pectineus. (15) Adductor longus. (16) Adductor magnus. (17) Gracilis. (A) Femoral artery. (B) Deep femoral. (C) Muscular branches. (I) Internal saphenous vein. (c) Branch of ilio-inguinal nerve. (e) Branches of internal cutaneous. (f) Middle cutaneous. (g) Saphenous branches. (h) Muscular branches of crural nerve. (i) Musculo-cutaneous branches of crural nerve.

Leg—(1) Tibia. (2) Internal malleolus. (4) External malleolus. (5) Metatarsal bones. (6) Fascia. (7) Anterior annular ligament. (9) Tibialis anticus tendon. (10) Extensor longus digitorum. (11) Extensor brevis digitorum. (12) Extensor hallucis longus. (13) Peroneus longus. (14) Peroneus brevis. (15) Gastrocnemius. (16) Soleus. (17) Abductor hallucis. (18) Interosseous. (b) Musculo-cutaneous nerves. (d) Dorsal cutaneous of foot. (e) Middle dorsal cutaneous. (f) Terminal branch of external saphenous. (g) Digital branches. (h) Anterior tibial. (h') Internal. (h") Internal branches of same

SECTION IV.

Thigh—(1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (13) Gracilis muscle. (14) Adductor longus muscle. (15) Adductor brevis. (16) Adductor magnus. (17) Insertion of pectineus muscle. (A) Femoral artery. (B) Deep femoral. (D') First perforating artery. (F) Muscular branches. (5) Tuberosity of tibia. (7) Ligamentum patellæ (middle part). (8) Internal lateral part. (9) Internal lateral ligament. (10) External lateral ligament (anterior part). (10') Posterior part. (11) Synovial capsule.

Leg and Foot—(1) Tibia. (2) Internal malleolus. (3) Fibula. (4) External malleolus. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (9) Anterior annular ligament. (10) Interosseous membrane. (10') Tibio-fibular ligament. (10") Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (13) External lateral ligament (anterior part). (14) Transverse metatarsal ligaments. (15) Capsular and lateral ligaments. (16) Peroneus longus and brevis muscles. (17) Tendons of extensor longus digitorum muscle, (18) of extensor longis pollicis, (19) of tibialis anticus. (20) Dorsal interosseous muscles. (A) Anterior tibial. (A') Dorsalis pedis.

SECTION V.

Thigh—(1) Femur. (2) Internal condyle. (3) External condyle. (4) Patella. (7) Ligamentum patellæ. (8) Lateral ligament of patella. (9) Internal lateral ligament of knee joint. (10) External lateral ligament (anterior part). (10') Posterior part. (11) Synovial capsule. (16) Adductor magnus. (17) Insertion of pectineus muscle. (A) Femoral artery. (B) Profunda femoris. (C) Descending branch of external circumflex artery. (D') First perforating. (D") Second perforating. (D'") Third perforating. (E) Nutrient artery of femur. (F) Muscular branches. (G) Anastomotica magna. (H) Popliteal. (I) Muscular branches. (K) Superior external auricular. (L) Superior internal auricular. (M) Middle articular. (N) Sural branches. (O) Inferior external articular. (P) Inferior internal articular branches. (Q) Anterior tibial.

Leg and Foot—(1) Tibia. (2) Internal, (3) External malleolus. (4) Fibula. (5) Tarsus. (6) Metatarsus. (7) First phalanges. (8) Second phalanges. (10) Interosseous membrane. (10') Tibio-fibular ligament. (10") Superior external malleolar ligament. (11) Internal lateral or deltoid ligament. (12) Astragalo-scaphoid. (13) Anterior external lateral. (13') Middle external lateral. (14) Transverse metatarsal. (15) Capsular ligaments. (A) Anterior tibial artery. (A') Dorsalis pedis. (B) Recurrent tibial. (C) External malleolar. (C') Internal. (D) External tarsal. (D') Internal tarsal. (D") Anterior tarsal. (E) Metatarsal. (F) Dorsal interosseous. (F') Dorsalis hallucis. (F") Deep plantar branch of same. (G) Posterior tibial. (H) Peroneal. (H') Anterior peroneal. (K) Posterior internal malleolar. (K') Posterior external. (L) Internal plantar. (L') Internal superficial branch. (M) External plantar. (N) Superior plantar arch. (O) Sural branch.

SECTION VI.

Thigh—(1) Femur. (2, 3) Internal and external condyles. (4) Patella. (5') Tuberosity of tibia. (6) Head of fibula. (7) Ligamentum patellæ. (8) Internal lateral part. (9) Internal lateral ligament of knee. (10, 10') External lateral ligament. (11) Synovial capsule. (a) Anterior obturator nerve. (b) Internal cutaneous. (c) Anterior internal cutaneous. (d) Long saphenous. (e) Great sciatic. (f) External popliteal or peroneal. (f') Posterior cutaneous branches of leg. (i

Internal popliteal nerve. (k) Sural or long cutaneous nerve. (1) Anterior external cutaneous.

Leg and Foot—(Figures refer to same as in preceding plate).—(a) Long saphenous nerve. (b) Musculo-cutaneous or superficial peroneal. (c) Anterior cutaneous branches. (d) Internal cutaneous branch of foot. (e) Middle cutaneous branch. (f) Posterior external cutaneous of leg. (g) Digital branches. (h) Anterior tibial. (h’) Internal branch. (h”) External branch. (i) Posterior tibial. (k) External saphenous branch. (k’) External cutaneous branch. (l) Internal plantar. (m) External plantar. (n) Digital plantar.